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THE CHOICE OF WINDOWS DEPENDING ON THEIR EXPOSURE. MEMO FOR FOREMEN.

(Choix des fenêtres en fonction de leur exposition. Memento pour les maitres d'oeuvre.)

by

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THE CHOICE OF WINDOWS DEPENDING UPON THEIR EXPOSURE

MEMO FOR ARCHITECT

SUMMARY

1. Purpose of document

Standard P20 302 classifies windows according to their performance under tests for air permeability, water tightness and wind resistance.

The purpose of this document is to provide foremen with data serving as a guide in the choice of type of window having regard to its position and particularly to its exposure to wind.

2. Field of application

This document applies to all windows falling within the scope of Standards NF P20 501 and NF P20 302 used in buildings of normal use*

Windows installed in buildings used for other purposes or in buildings put to normal use but of greater height (exceeding 100 m) are not covered by this document.

This document can only make recommendations of a general nature. It is up to the foreman himself to decide whether (a) local climatic conditions (buildings in mountains or in estuaries etc) and (b) the shape of the building and its location vis-a-vis other buildings (particularly where the height exceeds 50 m) are likely to create conditions on some or all of the sides, calling for the use of windows differing in performance from those referred to below.

3. Factors taken into consideration in defining the exposure of a window

The only document at present which deals with the effects of wind upon buildings faces is the DTU document "Rules defining the effects of snow and wind on structures" known as Rules N.V.65 which are in the process of being revised.

Drawn up for the purpose of stability calculations, that document is not entirely adapted to the problems connected with the windows dealt with in this memo.

The wind effects to be taken into account go hand in hand with the nature of the problem involved and the requirement laid down, for example: wind pressures considered in the case of air-tightness problems are not the same as those taken into account in the case of wind resistance. It thus becomes necessary to define for each particular problem concerned categories of exposure or pressure levels. Such data depend on a number of common factors as defined below.

3.1 Region

From this aspect distinction is made between:

- the region A which includes localities at altitudes equal to or below 1000 metres, situated in the area shown unshaded on the following map**
- region B which includes localities at altitudes above 1000 metres situated in the area shown unshaded on the map and all localities in the area shown shaded***

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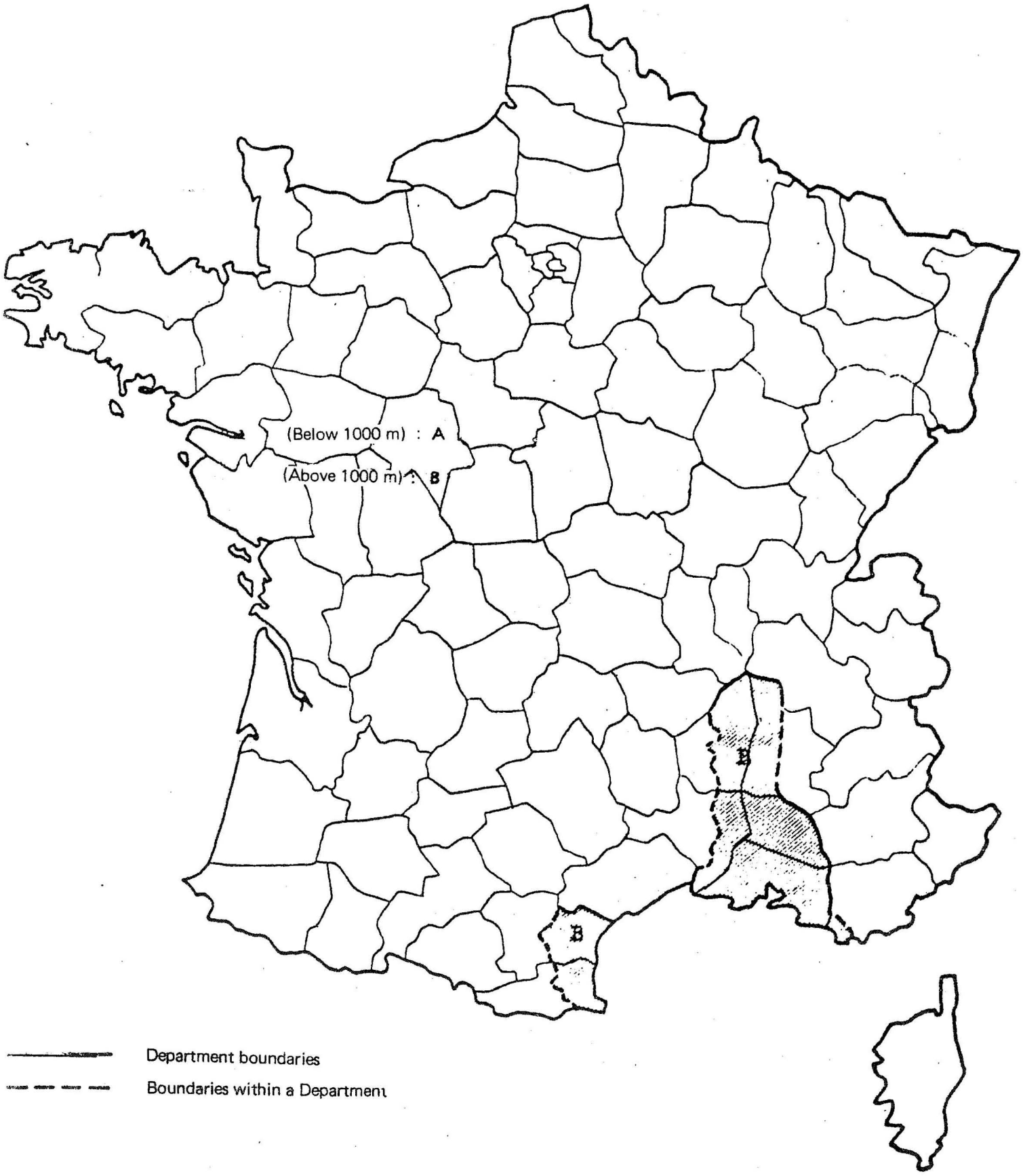
* "Normal use" refers mainly to dwelling houses, schools and office blocks.

** This area corresponds largely to regions 1 and 11 in rules NV65

*** This area corresponds largely to the region III in rules NV65.


(Below 1000 m) : A
(Above 1000 m) : B
B
B
Department boundaries
Boundaries within a Department

3.2 Location of building

There are four distinctions under this heading, viz:

(a) buildings situated within large city centres (towns where at least half of the building have more than 4 floors)

(b) buildings situated in small or medium sized towns or on the outskirts of large city centres.

(c) isolated buildings in open country

(d) isolated buildings situated by the sea or in coastal towns where such buildings are less than 15 times their own height in distance from the coast line, and providing that the windows concerned are in non-sheltered frontages (cf. para. 3.4 below).

In certain instances, by the sea, strong winds blow from inland; this applies generally speaking to the Mediterrenean coastline situated in area B; in this case, windows, whose position corresponds with the previous definition will be considered as those under (c).

3.5 Height of window above ground

Windows from this aspect can be differentiated according to the respective position, viz:-

- at least 6 m above ground level

- between 6 and 18 m

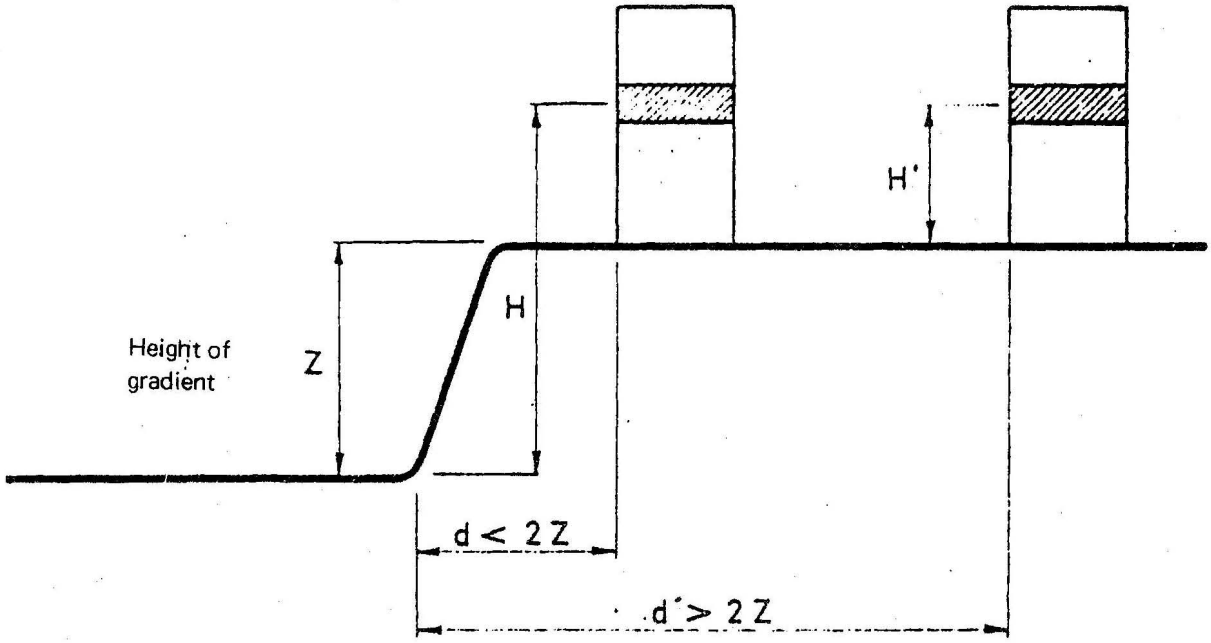
- between 18 and 28 m

- between 28 and 50 m

- between 50 and 100 m

When the building is situated at the top of a gradient averaging more than 1, the height above ground is taken from the foot of the gradient except where the building is situated at a distance from the latter greater than twice the height of the gradient itself. The figure below illustrates an example. H and H' represent the heights above ground to be considered in respect of two appartments on the same level in two identical buildings, one of which is situated near the top of a gradient the other however being situated further away at a distance equivalent to over twice the height of the gradient.

Note: When a building is well isolated and of considerable length, it is possible that the pressure exerted by the wind at lower levels is close to that at high levels; under such circumstances the height above ground to be adopted for any level will no longer be the height at that level but that of the highest level.



3.4 The presence or absence of protection against the wind (shielding effect)

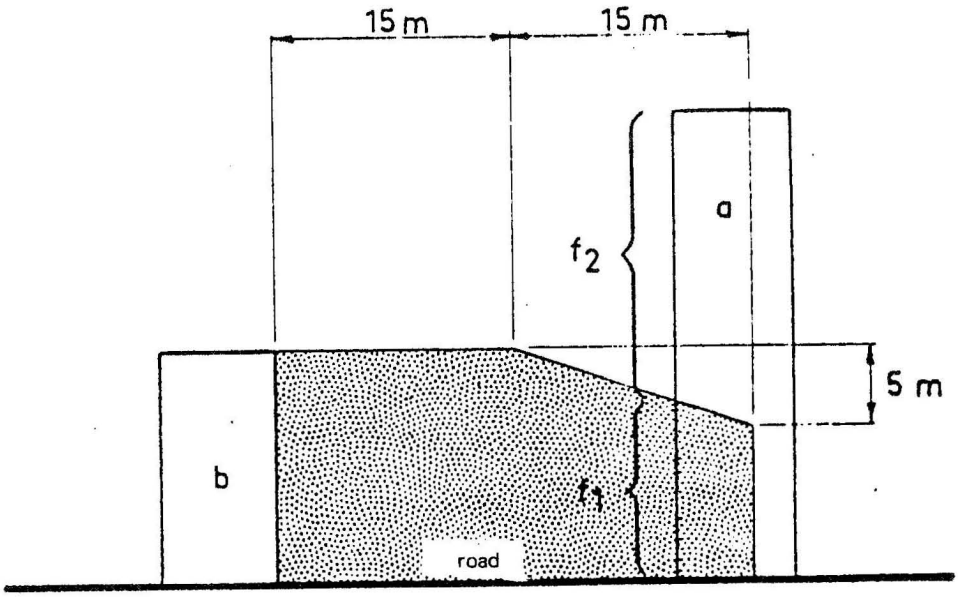
Distinction is made from this aspect between

- sheltered frontages
- unsheltered frontages

A sheltered frontage is one which faces the road, (assuming a road to be flanked by a continuous line of buildings) with other buildings opposite:

- situated not more than 15 m away and whose height is at least equal to that of the frontage or to that portion of frontage considered.
- or situated at a distance between 15 and 30 m and whose height exceeds that of the frontage, or the part of the frontage considered, by an amount equivalent to at least one third of anything exceeding 15m in the distance separating the frontage and the buildings opposite.

The following figure illustrates the definition



The part of frontage f_1 of building (a) is sheltered by building (b).

The part of frontage f_2 is not shielded by building (b). Frontages sheltered at heights exceeding 28 metres are quite exceptional.

4. AIR PERMEABILITY

4.1 Requirement

The recommendations below have been drawn up with a view to:

- reducing heat losses, aimed at keeping heating systems to a minimum, and consequently power consumption
- avoiding cold draughts and lack of balance between heating and ventilation.

4.2 Definition of categories of exposure to wind for air permeability problems

For this problem, average wind pressures for the year are taken into account.

Depending upon the factors defined in paragraph 3, distinction is made between four categories of wind pressure referred to as Ex_1, Ex_2, Ex_3 and Ex_4 in the table below.

HEIGHT OF WINDOW ABOVE GROUND	SHELTERED FRONTAGE	UNSHELTERED FRONTAGE				
	REGIONS A and B	REGION A		REGION B	REGION A and REGION B	
	Situations a and b	Situations a and b	Situation c	Situations a and b	Situation d	Situation c
< 6 m	Ex_1	Ex_1	Ex_1	Ex_2	Ex_2	
6 to 18 m	Ex_1	Ex_1	Ex_2	Ex_2	Ex_3	
18 to 28 m	Ex_1	Ex_2	Ex_2	Ex_3	Ex_4	
28 to 50 m		Ex_2	Ex_3	Ex_3	Ex_4	
50 to 100 m		Ex_3	Ex_3	Ex_4	Ex_4	

4.3 Choice of categories of air permeability

The choice of category of air permeability depends upon:

* type of exposure

* area of opening parts in relation to the area of the premises

* Overall heat insulation required for the building: from this aspect the following distinction is made

- Buildings for which heat insulation is not required (for example, buildings not intended to be heated); these are referred to as type 0 in the table below.

- buildings such as those normally constructed to conform with the heat insulation recommendations given in the general Techn. Clauses of the HLM*: the coefficients of loss per volume (coefficient G) of these buildings correspond to the values given in table 2.14 "non-electric" heating in the document "Examples of solutions to facilitate the application of building regulation - section 1 - HYGROTHERMAL"**. These buildings are referred to as type I in the following table.

- Buildings where near to perfect heat insulation is required, the coefficients G then corresponding to the values indicated in table 2.14. "Electric heating" of the above mentioned document. These are referred to as type II in the following table.

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* Document published in the CSTB specifications No. 882 (July/Aug. 1969)

** Document published in the CSTB specifications No. 1152 (Dec. 1972)

£: These G coefficients are close to those prescribed under Decree of the 10th April 1974 dealing with the heat insulation in dwelling houses:

the G coefficients: buildings of type 1 correspond closely to the coefficients G prescribed in the "first stage"

The G coefficients: buildings of type II correspond closely to the coefficients G prescribed in the "second stage"

The conditions under 4.1 are considered satisfied if the categories of air permeability of windows A1, A2 and A3 as defined in standard NF P 20 302 are chosen in accordance with the indications provided in the following table.

Categories of air permeability of windows

Type of building	Ratio of area of opening parts to building area	Categories of exposure			
		Ex_1	Ex_2	Ex_3	Ex_4
Type 0		-	-	A_1	A_1
Type I	≤ 1/6	-	A_1	A_1	A_2
	Between 1/6 and 1/4	A_1	A_1	A_2	A_2
	≥ 1/4	A_1	A_2	A_2	A_3
Type II	≤ 1/6	A_1*	A_2	A_2	A_3
	Between 1/6 and 1/4	A_2	A_2	A_3	A_3
	≥ 1/4	A_2	A_3	A_3	A3**

NOTE I: The sign - indicates that unclassified windows may be used

* windows with double glazing will preferably be chosen from class A2

** large size opening windows are not recommended in this case

NOTE II: Tolerance is allowed on the limits shown in order to keep windows the same in buildings of slightly different area

NOTE III: This table does not apply to windows whose joints are specially designed to form ventilation air inlets; cf article 1.32 of Examples of solutions for facilitating the application of building regulations - section II - ventilation" appearing in the CSTB specifications No. 124 part 1071.

Apart from heat problems, a limited degree of air permeability is also necessary in order to retain for a window the properties of acoustic insulation from external noises which its glazing provides.

In particular, the attainment of the values indicated in the Decree of the 10th February 1972, dealing with "Acoustic Comfort" implies in the zone of noise II, besides a special glazing, a window of at least A2 category.

NOTE: The satisfying of thermal and acoustic comfort requirements calls naturally for conditions other than those relating to the air permeability of single windows; in particular it is advisable to ensure the air tightness of adjacent items (rolling shutter housing, wall joints etc...)

These conditions can be found in "Examples of solutions for facilitating the application of building regulations - section 1 HYGROTHERMICS - Section III ACOUSTICS."

5. WATER TIGHTNESS

5.1 Requirement:

Windows must remain water-tight in face of the combined effects of wind and rain (lashing rain) under conditions likely to reoccur once every 3 years on average.

It will be remembered (cf.3.2 NP P 20.302) that a window is considered water-tight if, under the test conditions, there are no continuous or recurring water penetrations affecting parts of the building which are not meant to be wet.

As a general rule, a window selected in accordance with paragraph 5.3 should not allow large scale water penetrations under conditions likely to be repeated on average every 10 years.

5.2 Definition of categories of exposure to driving rain

The definition of exposure of walls to driving rain depends upon the following factors:

- situation
- height above ground
- degree of protection if any against the wind

In view of what is known regarding driving rain (combination of wind and rain) there is no need to differentiate between regions: it should also be observed that

- the Mistral and the Tramontana, which gave rise to region B, are winds which are rarely accompanied by rain.
- the rainfall period, which varies from region to region, is a secondary factor as regards the penetration of rain in window joints.
- the frequency of rainfalls which likewise varies from region to region only entails minor modifications, the frequency of the conditions possibly producing infiltrations.

.3 Choice of categories of water tightness

The requirement stipulated under 5.1 is considered as being satisfied if the window water tightness categories E_1, E_2, E_3 and the exceptional category E_E as defined in standard NF P20 302 are chosen in accordance with the details given in the table and the text of this article.

Height of window above ground	REGIONS A AND B			
	Sheltered frontage	Unsheltered frontage		
	Situations a and b	Situations a and b	Situation c	Situation d
< 6 m	E_1	E_1	E_1	E_2
6 to 18 m	E_1	E_1	E_2	E_2
18 to 28 m	E_1	E_2	E_2	E_3
28 to 50 m		E_2 (E_3)*	E_2 (E_3)*	E_3
60 to 100 m		E_3	E_3	E_E

In regions where winds on rainy days are in a well specified direction, the building foreman can adopt category E_1 in the case of windows on walls facing the opposite direction.

Windows and French windows which are well recessed (loggia with a depth of more than .90 m) can, with the exception of French windows in buildings more than 18 m high in situation d, and more than 50 m high in situation a, b, c, be chosen from the category immediately below that indicated in the table, category E_1 however being the minimum permissible.

NOTE: It will be remembered that the tests standard NF 20 501 stipulates that windows whose top rail has to be flush with the bare exterior of the lintel without any protection, should be tested using a special watering device. In such a case, it is advisable to ensure that the window performance is determined under particular watering conditions.

6. WIND RESISTANCE

6.1 Requirement

Whatever purpose it is intended to serve, the window must be sufficiently rigid, that under a pressure of 500 Pa the bend in a component member subjected to greatest stress, apart from the glazing, is below 1/200 of its span, with the reservation of the special conditions referred to in the last paragraph of article 6.2 below.

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* Windows at the two last building levels more than 28 m high will be taken at least from class E_3.

After having been subjected to the action of a wind which has a return pe of 5 years, the window should retain its properties and not present any residual distortion. The window should withstand the effects of a wind with a return period of 30 years; under these conditions the behaviour of the window should not present any hazards to the user.

6.2 Choice of wind resistance category

The conditions stipulated in 6.1 will be satisfied if the categories of wind resistance V_1, V_2 in respect of windows, or the exceptional category V_E as as defined under standard NF P20 302 are chosen in accordance with the table below:

Categories of wind resistance for windows

Height of window above ground	Sheltered face	Unsheltered face						
	REGIONS A and B	REGION A				REGION B		
	Situations a and b	Situation				Situation		
		a	b	c	d	a	b	c
<6 m	V_1	V_1	V_1	V_1	V_2	V_1	V_1	V_2
6 to 18 m	V_1	V_1	V_1	V_2	V_2	V_1	V_2	V_2
18 to 28 m	V_1	V_1	V_1	V_2	V_2	V_2	V_2	V_E
28 to 50 m		V_1	V_2	V_2	V_E	V_2	V_2	V_E
0 to 100 m		V_2	V_2	V_2	V_E	V_2	V_E	V_E

In cases where a category V_E window is required, reference will be made to the following tables in order to determine the test pressures to be applied.

NOTE: Windows produced by request for a specific purpose can be tested at pressures corresponding to that situation (cf note 3 para 4 of standard P20 302).

Under these conditions the following table 1 below gives the maximum pressures to be applied during the distortion test provided for in standard P20 501, para 4.11, and table 11 the pressures applicable during the sudden pressure test as prescribed in standard P 20 501, para 4.12.

In any case the bend criterion under a pressure of 500 Pa must be observed.

I PRESSURES IN PA TO BE APPLIED ON WINDOWS FOR DISTORTION TEST

(4.11 of Standard NF P 20 501)

Height of window above ground	Sheltered face	Unsheltered face						
	REGIONS A and B	REGION A				REGION B		
	Situations a and b	Situation				Situation		
		a	b	c	d	a	b	c
< 6 m	500	500	500	500	800	500	500	750
6 to 18 m	500	500	500	600	950	500	600	950
18 to 28 m	500	500	500	700	1000	550	750	1050
28 to 50 m		500	600	750	1050	750	950	1200
50 to 100 m		600	750	900	1150	1000	1200	1450

TABLE II PRESSURES IN PA TO BE APPLIED ON WINDOWS FOR THE SUDDEN PRESSURE TEST

(4.12 of Standard NF P 20 501)

Height of window above ground	Sheltered face	Unsheltered face						
	REGIONS A and B	REGION A				REGION B		
	Situations a and b	Situation				Situation		
		a	b	c	d	a	b	c
< 6 m	900	900	900	900	1400	900	900	1300
6 to 18 m	900	900	900	1100	1600	900	1100	1600
18 to 28 m	900	900	900	1200	1700	1000	1300	1800
28 to 50 m		900	1100	1300	1800	1300	1600	2000
50 to 100 m		1100	1300	1500	1900	1700	2000	2300

The attention of foremen is drawn to the fact that the pressures indicated in the above tables are only valid for windows on flat frontages of relatively low building.

In other cases and particularly in the case of buildings exceeding 50 m in height, it is necessary to determine the pressures and/or depressions to be used for test purposes.

7. SUMMARY TABLE

The table below summarizes as a function of the different exposures, the recommended categories of air and water tightness and wind resistance.

- Exposures are defined according to the factors described in Section 3

- The categories of window are those as defined in Standard NF P 20 302

The air permeability categories, appearing in the table have been allocated a + or - index the significance of which is as follows:

The index " - " indicates that in the case of windows whose moving sections area related to the building surface area is equal to or less than 1/6, windows belonging to the category immediately below the one indicated may be used; for example: A_1 means that in this case unclassified windows may be used.

the index " + " indicates that in the case where the above ratio is equal to or greater than 1/4, windows of the category immediately above that shown must be used; for example A_1^+ means that in this case A_2 windows should be used.

The table has been drawn up for type 1 buildings as defined under Section 4.3; in the case of type 11 buildings it is advisable to chose the category of air permeability immediately above the one indicated in the table.

From the table it will be seen that windows classified as

A_1, E_1 V_1

and

S_2 E_2 V_2

cover the greater part of the requirements for type 1 buildings. The sectors of use of windows thus classified are shown on the table respectively in light and dark shading.

HEIGHT OF WINDOW ABOVE GROUND	SHELTERED WALL FACES	NON-SHELTERED WALL FACES						
	REGIONS A and B	REGION A				REGION B		
	SITUATIONS a and b	Situation				Situation		
		a	b	c	d	a	b	c
< 6 m	$A_1^- E_1 V_1$	$A_1^- E_1 V_1$	$A_1^- E_1 V_1$	$A_1^- E_1 V_1$	$A_1^+ E_2 V_2$	$A_1^+ E_1 V_1$	$A_1^+ E_1 V_1$	$A_1^- E_1 V_2$
6 to 18 m	$A_1^- E_1 V_1$	$A_1^- E_1 V_1$	$A_1^- E_1 V_1$	$A_1^+ E_2 V_2$	$A_2^- E_2 V_2$	$A_1^+ E_1 V_1$	$A_1^+ E_1 V_2$	$A_2^- E_2 V_2$
18 to 28 m	$A_1^- E_1 V_1$	$A_1^+ E_2 V_1$	$A_1^+ E_2 V_1$	$A_1^+ E_2 V_2$	$A_2^- E_3 V_2$	$A_2^- E_2 V_2$	$A_2^- E_2 V_2$	$A_2^+ E_2 V_2$
28 to 50 m		$A_1^+ E_2^* V_1$	$A_1^+ E_2^* V_2$	$A_2^- E_2^* V_2$	$A_2^+ E_3 V_E$	$A_2^- E_2^* V_2$	$A_2^- E_2^* V_2$	$A_2^- E_2^* V_2$
50 to 100 m		$A_2^- E_3 V_2$	$A_2^- E_3 V_2$	$A_2^- E_3 V_2$	$A_2^+ E_E V_E$	$A_2^+ E_3 V_2$	$A_2^+ E_3 V_E$	$A_2^+ E_3 V_E$

* E_3 for windows of the last two levels.